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OPERATION
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telonic™
TELONIC INSTRUMENTS
A Division of Telonic Industries, Inc.
60 N. First Avenue
Beech Grove, Indiana 46107

OPERATION
AND
SERVICE MANUAL
T.O.S. NO. 112D

MODEL SM-2000 SWEEP/SIGNAL GENERATOR

TELONIC INSTRUMENTS™
A Division of Telonic Industries, Inc.
60 N. First Avenue
Beech Grove, Indiana 46107

telonic

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CONVERSION INFORMATION

Commencing with equipment shipped after about July 22, 1963, certain modifications have been incorporated in the Telonic SM-2000 plug-in series, and in the Telonic SM-2000 control chassis. These modifications may render the units incompatible with those previously shipped unless the earlier instruments are modified also. The equipment in which these modifications have been made can be identified by the letter "A" prefixed to the serial number.

Units not so identified must be modified if they are to be compatible with instruments now being shipped. The modifications to be made are listed below, divided into two groups - those to be made to earlier SM-2000's and those to be made to earlier plug-ins.

SM-2000 CHANGES

1. On J601, remove all wires presently connected to pin 8 and reconnect them at pin 7; remove the jumper between pins 7 and 8.

2. Using shielded wire, type RG-174/U or equal, connect pin 8 of J601 to the printed circuit board land which leads to pin 1, V303. Ground the shield by connecting it to a convenient ground land nearby.

3. Prefix the letter "A" to the serial number of the instrument.

PLUG-IN CHANGES

1. On P601 remove all wires presently connected to Pin 8 and reconnect them at pin 7; remove the jumper between pins 7 and 8 if one is connected.

2. Prefix the letter "A" to the serial number of the instrument, if none is prefixed.

Changing the serial number of the instrument is as important in the modification as are the electrical requirements, as the ability to identify a unit as having been or not having been modified is involved.

SECTION I

GENERAL INFORMATION

1-1. SPECIFICATIONS.

1-2. Table 1-1. lists the specifications for the MODEL SM-2000 SWEEP/SIGNAL GENERATOR.

TABLE 1-1.

Specifications	
RF Output-	1 Vrms (typical) (depending upon oscillator used)
Output Flatness	
With Internal Monitor-	±0.25 dB (typical)
With External Monitor-	±0.10 dB (typical)
Source Impedance-	50 ohms
RF 1 Attenuation-	0-60 dB in 1 dB steps (typical accuracy to 900 MHz ±10% or ±0.7 dB, whichever is greater)
RF Vernier Level Control-	0-6 dB of range (typical) (depending upon plug-in)
Operating Modes	
Sweep-	RF output swept at line frequency with "E" and "S" models. Sweep Rate determined by SWEEP RATE Switch with "L" models
Modulated Sweep-	Swept RF output modulated with an internally generated 1 kHz square wave
CW-	RF output is a CW signal
Modulated CW-	CW signal is modulated with an internally generated 1 kHz square wave
Zero Reference Line-	Provided in sweep and modulated sweep modes by blanking the oscillator during return sweep
Sweep Rate	
Electronically Swept Plug-in units	
Variable-	0.01-100 Hz
Line Frequency-	50/60 Hz
Manual Drive-	Automatic drive switched off and sweep rate controlled manually

TABLE 1-1. (Cont)

External Drive-	Rear Panel connection is provided for driving with external signal
All Other Plug-in Units-	Line frequency (50/60 Hz)
Sweep to Retrace Ratio	
Variable Sweep Rate-	1:1 or (approx) 10:1 (Controlled by Front Panel SWEEP RATIO Switch)
Line Sweep Rate-	1:1 only
Horizontal Output-	Approximately 15 V peak-to-peak Approximately 0 V dc average Triangular or sawtooth waveform with electronically swept plug-ins. Sine wave with all other models
Marker System	
Birdy-By-Pass Marker Circuitry-	The outputs of the marker oscillators are mixed with a signal from the sweep oscillator to produce beatnotes or "birdies." These birdies are amplified and superimposed upon the detected RF output signal before it is applied to the vertical scope input. Amplitude and shape of the markers are adjustable over a wide range
Variable Marker-	Circuitry is provided to accept either RF or birdy plug-ins which include a variable marker oscillator
External Marker Input-	An external CW signal of approximately 0.1 V may be used to produce a "Birdy" type marker
Plug-in Crystal Markers-	Provisions are included for up to eight single frequency or harmonic type plug-in crystal-controlled markers. These markers are optional and may be included in the instrument or added at a later date
Rectified Markers-	For use with X-Y recorders; a marker rectifier is included
Power Requirements-	115/230 V ac, 50/60 Hz (approx 200 watts)

1-3. DESCRIPTION. (Refer to figure 1-1.)

1-4. The SM-2000 control chassis contains circuitry which is common to a wide variety of other sweep and signal generators in all frequency ranges, as well as special-function circuits not contained in most other instruments; for example:

a. Power supply

b. Monitor and automatic level control circuit

c. RF attenuator

d. Variable sweep rate circuit

e. Sweep drive and horizontal output circuit

f. Marker mixer and marker amplifier ("Birdy-By-Pass" Marker System)

g. Blanking circuit

h. Internal square wave modulation circuit

i. All controls not associated with the particular requirements of the plug-in oscillator

1-5. The circuitry necessary to generate the desired RF signal(s), including the variable marker if any, is contained in a separate plug-in oscillator unit. The mating contacts on each plug-in select the control chassis functions which are required for that plug-in and switch certain controls contained in the plug-in into the proper control chassis circuits.

1-6. The SM-2000 operates in any one of four modes:

a. Modulated Sweep
b. Sweep
c. CW
d. Modulated CW

1-7. The modulation in the two modulated modes is a 1kHz square wave which turns the sweep oscillator on and off during alternate half-cycles. The 1kHz square wave is generated in the SM-2000.

1-8. There are three general types of plug-ins. They are distinguished by a model number in which the first letter designates the method of sweeping:

a. "L" Models, with an electronic sweep.
b. "S" Models, with a mechanical sweep.
c. "E" Models, similar to "S" Models except that an additional (RF 2) output at a harmonic frequency is generated. This output is available on the front panel of the plug-in, rather than on the SM-2000.

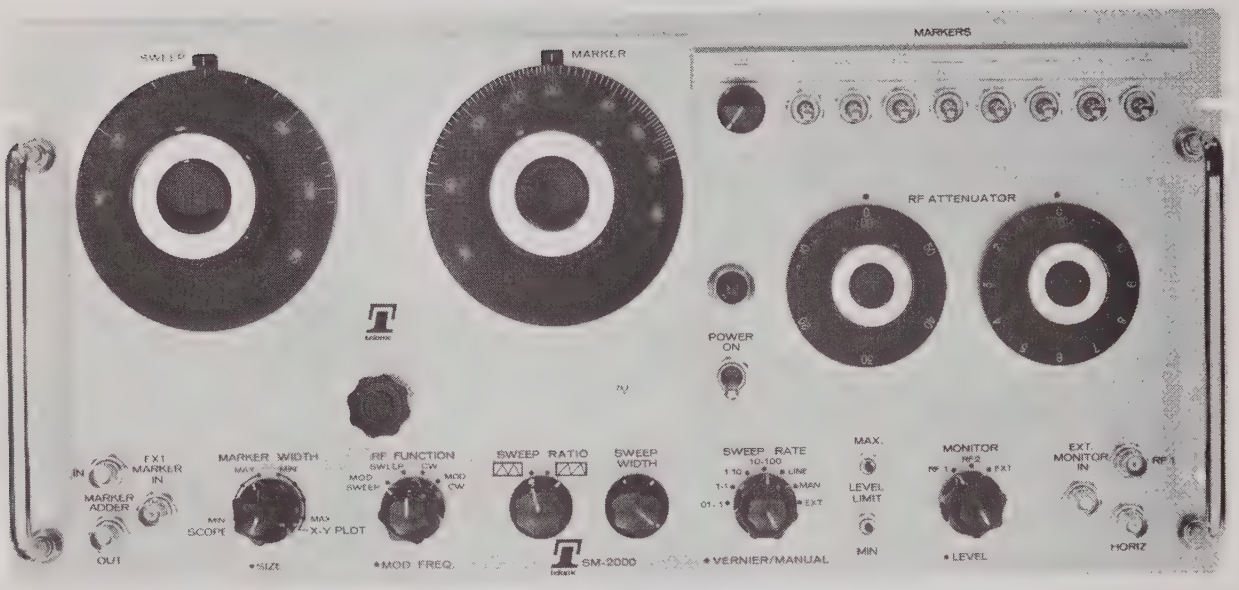

Figure 1-1. SM-2000 SWEEP/SIGNAL GENERATOR CONTROL CHASSIS

1-9. Other letter used in the model number have the following significance:

"A"--Audio and low video frequencies
"B"--Band switching model
"H"--Heterodyne output
"M"--Variable marker included in plug-in

1-10. With the electronically swept models only, a choice of four sweep techniques is available:

a. Variable rate from 0.01 to 100 Hz with vernier control
b. Line (50/60 Hz) synchronized sweep
c. External sweep drive
d. Manual sweep

1-11. Also a choice of 1:1 or 10:1 sweep to retrace ratio is provided with the variable sweep rate. A scope horizontal output which is an attenuated replica of the sweep drive waveform is provided in each case.

1-12. In all other plug-ins, the sweep is driven by a sinusoidal voltage from the power transformer, and the horizontal output voltage is also a phased sine wave at line frequency.

SECTION II

OPERATING INSTRUCTIONS

2-1. GENERAL.

2-2. This section provides the complete functional control description and operating instructions for the SM-2000 SWEEP/SIGNAL GENERATOR CONTROL CHASSIS.

2-3. Refer to figure 2-1. for typical Sweep/Signal Generator Setup.

2-4. Plug in the RF oscillator for frequency range desired. Never plug in a unit while the power is on. Transient voltages may result in diode damage.

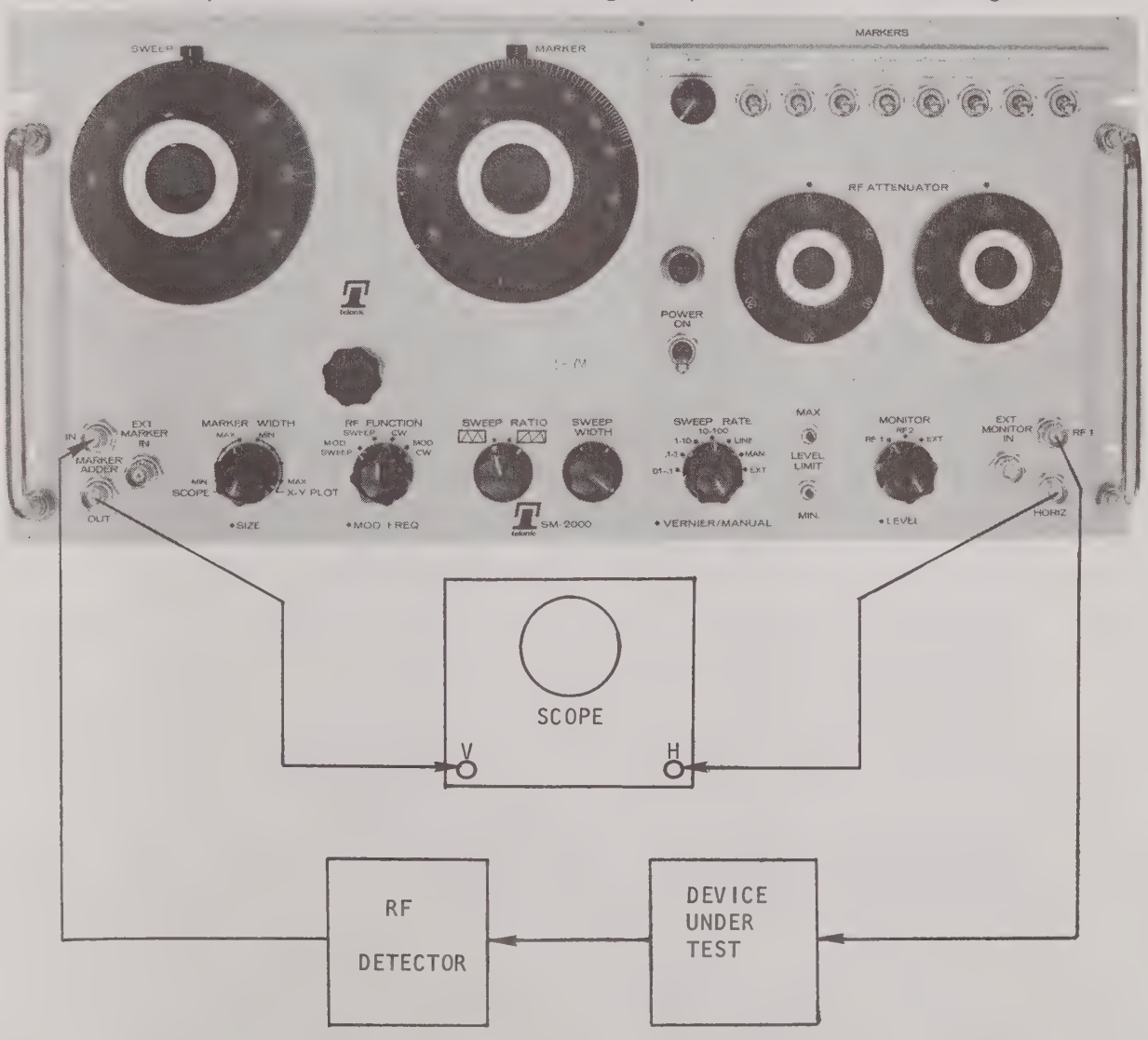

Figure 2-1. Typical Sweep/Signal Generator Setup

2-5. Make connections to the scope (or recorder), the device under test, and RF detector as shown in figure 2-1. All connectors located on the sweep generator are BNC Type. The cable that is used to connect the RF OUTPUT to the device under test should match the impedance of the sweep generator. If the input impedance of the device under test is different from the impedance of the sweep generator, a matching network should be used to ensure a constant input signal. It is recommended that RG cable be used for all connections. This ensures good ground connection between the devices and minimizes hum, leakage from the unit, and pickup of spurious external signals.

2-6. Make sure that S102 is set for the power line voltage available and plug in the line cord.

2-7. The versatility of the SM-2000 and the wide variety of plug-ins available make the listing of step-by-step operating procedures for all possible applications impossible. A study of the remainder of this section, in which the function of each panel control is discussed, will indicate clearly the control settings necessary in each particular application.

2-8. FRONT PANEL CONTROL DESCRIPTION.

2-9. POWER Switch.

2-10. This switch connects ac power to the SM-2000 power transformer primaries.

2-11. RF FUNCTION SWITCH (S403).

2-12. This switch provides a means to select one of four modes or operation, MOD. SWEEP, SWEEP, CW or MOD CW.

2-13. MOD. SWEEP position.

2-14. Both a blanking signal and a 1 kHz square wave are supplied to the B+ pass tube, which controls the operating level of the RF oscillator in the plug-in. A sweep drive is supplied to the drive motor or electronically variable reactor, resulting in a swept RF output modulated with a 1 kHz square wave. The return sweep is blanked.

2-15. SWEEP position.

2-16. The sweep drive and blanking signals are supplied but the 1 kHz oscillator is disabled. The return sweep is blanked.

2-17. CW position.

2-18. In this mode the SM-2000 is a signal generator. The output is an unmodulated RF voltage.

2-19. MOD. CW.

2-20. The 1 kHz square wave is coupled to the pass tube, but the sweep drive and blanking circuits are disconnected.

2-21. LEVEL CONTROL (R304).

2-22. This control is the electronic vernier for the RF operating level of the plug-in oscillator. It varies the B+ available to the oscillator tube between the limits imposed by the settings of the LEVEL LIMIT Controls.

2-23. The LEVEL Control can be used to set the RF 1 output at levels between attenuator steps. It also provides a manual output control when the RF 2 monitor or an external monitor is in use (the turret attenuator is not used with these monitors). This control is inoperative with plug-in oscillators in which B+ is not controlled by the SM-2000 leveler circuit.

2-24. LEVEL LIMIT CONTROLS.

2-25. These controls are set to provide the desired range for the LEVEL Control.

2-26. The MAX. LIMIT Control sets minimum voltage available at the wiper arm of the level control potentiometer, and hence the maximum average B+ at the pass tube. With the device under test in the TYPICAL SETUP bypassed and the LEVEL control fully clockwise (maximum setting), this control is set for specified oscillator output.

2-27. The MIN. LIMIT Control sets the maximum voltage available at the wiper arm of the level control potentiometer, and hence the minimum average B+ at the pass tube. With the device under test by-passed, this control is set for the desired level below that set with the MAX. Control. This can be done as follows:

a. Modify the TYPICAL SETUP to omit the device under test.

b. With the LEVEL and MAX. Controls set as above, insert the number of dB of fixed attenuation corresponding to the desired range of the LEVEL control, not to exceed the range specified in the plug-in manual, and note the scope deflection.

c. Remove attenuation, set LEVEL Control fully counter-clockwise, and set the MIN. LIMIT for the same scope deflection as noted in step b.

2-28. RF ATTENUATOR.

2-29. These attenuators are used with the RF 1 output only, and only when an external monitor is not used.

2-30. Two turret attenuators in series provide up to 60 dB of attenuation in 1 dB steps. One unit has a 0-50 dB range in 10 dB steps and the other 0-10 dB in 1 dB steps. They are set to provide either the desired level at the output or the desired amount of attenuation, depending on the application. The total attenuation is the sum of the two dial readings.

2-31. MONITOR SWITCH (S301).

2-32. This switch selects the automatic level control (ALC) signal from one of three sources: A monitor in the SM-2000, a monitor in the plug-in, or an external monitor. For proper ALC action, the MONITOR SWITCH must be set in the proper potition:

a. RF 1: The ALC signal, proportional to the RF 1 output level, is provided by the SM-2000 monitor. The ALC circuit then automatically levels the RF 1 signal.

b. RF 2: The ALC signal, proportional to the RF 2 output level, is provided by a monitor in the plug-in. The ALC circuit then automatically levels the RF2 signal.

c. EXT: The ALC signal, proportional to whichever output signal is used, is provided by a monitor external to the SM-2000. This monitor usually is connected at, or very near, the point of application of the RF signal to the device under test in order to take advantage of the shorter connections possible.

2-33. EXT MONITOR IN CONNECTOR (J301).

2-34. The DC output (ALC signal) from the external monitor is returned to the ALC circuit through this connector.

2-35. RF 1 CONNECTOR (J212).

2-36. The RF 1 output is taken at this point. It may be fed to the device under test directly or through an external monitor. Connectors for other outputs are located on the plug-ins.

2-37. SWEEP RATE SWITCH (S401).

2-38. The position of this switch is immaterial if the plug-in employs a mechanical sweep.

2-39. With electronically swept plug-ins, the circuit functions corresponding to each switch position are as follows:

a. LINE: A line-synchronized (50/60 Hz) signal triggers the "vari-rate" circuit to produce a triangular waveform drive for the reactor.

b. MAN: The automatic sweep drive is disconnected, and the output is swept manually with the VERNIER/MANUAL control.

c. EXT: An external signal can be connected to the EXT DRIVE INPUT on the rear of the chassis to provide the reactor control.

d. Other Positions: The "vari-rate" circuit generates a sawtooth or triangular waveform without external trigger. The Sweep Rate Switch also acts as a coarse rate control in these positions, selecting the indicated one of the four ranges of the automatic sweep rate.

2-40. VERNIER/MANUAL CONTROL (R421 and R439).

2-41. This control is operative with the "L" model plug-ins only, and has no effect in the LINE and EXT positions of the SWEEP RATE switch.

2-42. In the MAN position of the SWEEP RATE switch, the frequency of the RF output is varied manually at any desired rate by R439.

2-43. In the variable rate positions of the SWEEP RATE Switch, R421 provides vernier rate adjustment within the indicated range.

2-44. Potentiometers R421 and R439 are ganged to a single Front Panel control knob, concentric with the SWEEP RATE Switch.

2-45. SWEEP RATIO SWITCH (S402).

2-46. This switch controls the sweep to retrace time ratio for "L" model plug-ins, giving a choice between a triangular or sawtooth sweep. This switch does not change the sweep rate and has no effect if the oscillator plugged in uses mechanical sweep or if the SWEEP RATE Switch is in the MAN, EXT, or LINE position.

2-47. SWEEP WIDTH CONTROL (R467 and R471).

2-48. These controls, ganged to a common shaft, vary the sweep drive amplitude and consequently the sweep width of the RF output.

2-49. R467 varies the sweep width for electronically swept oscillators. R471 is used for other units.

2-50. HORIZ. CONNECTOR (J402).

2-51. A horizontal deflection voltage for use with an oscilloscope, synchronized with the sweep rate, is provided at this connector. The waveform is sinusodial for mechanically swept oscillators and an attenuated replica of the sweep drive waveform for electronically swept models.

2-52. MOD. FREQ. CONTROL (R451).

2-53. This is a vernier control of the period of a cycle of the 1 kHz multivibrator, V405. This control should be set for an oscillation frequency of 1000 Hz.

2-54. MARKERS (S501 through S509).

2-55. Each of these switches controls an individual fixed marker (crystal plug-in unit), or the variable/external marker. The switches are in the B+ line to the marker units. The markers may be applied singly or in any desired combination. The VAR/EXT Switch is rotary and is ganged to the size control for these markers. Toggle switches are used for the fixed markers.

2-56. MARKER WIDTH CONTROL (R510).

2-57. This switch selects one of four standard marker widths in the 15-150 kHz range. It also selects either an unrectified birdy for oscilloscope presentations or a rectified birdy for X-Y recorders. All markers applied are affected by the setting of this switch. The width selected usually will be the minimum width which will provide a clear marker.

2-58. SIZE CONTROLS (R532 and R533).

2-59. These ganged controls vary the marker amplitude of all markers simultaneously. They usually are set for optimum viewing or clearly marked record.

2-60. EXT. MARKER IN CONNECTOR (J211).

2-61. Any external CW signal being used as a marker is fed in at this connector. Any such signal of approximately 0.01-1.0 V amplitude usually will be found suitable. Marker accuracy will be dependent upon the frequency tolerance of the external source, as untuned amplifiers are employed in the Birdy-By-Pass Marker System of the SM-2000.

2-62. MARKER ADDER CONNECTOR.

2-63. IN (J504).

2-64. The demodulated signal from the device being tested is fed into this connector. It is connected through a 47 kHz resistor to the OUT receptacle.

2-65. OUT (J503).

2-66. The markers from the Birdy-By-Pass marker systems are applied at this point. The markers bypass the device under test to provide better markers without interfering with the response curve. This connector should be coupled to the vertical input of the oscilloscope or to the Y-input of the X-Y recorder.

2-67. REAR PANEL DESCRIPTION. (Refer to figure 2-2.)

2-68. FUSE POST.

2-69. The fuse installed here should be 1.5A delayed action for 230 V operation, or 3A delayed action for 115 V operation.

2-70. EXT. DRIVE INPUT CONNECTOR.

2-71. A combination banana jack-binding post connector for external sweep control. Common ground between the SM-2000 and the source of the external sweep drive must also be provided. The external sweep drive signal should be a 100 volt peak-to-peak waveform at 70 V dc reference for full sweep width and proper operation. This connector is used with electrically swept plug-ins only.

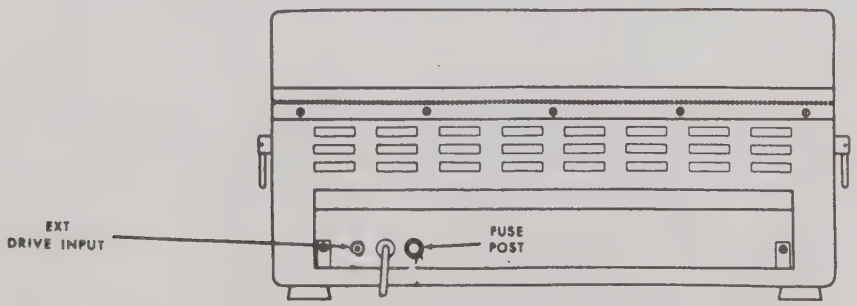

Figure 2-2. SM-2000 Rear Panel

SECTION III

PRINCIPLES OF OPERATION

3-1. GENERAL.

3-2. This section provides a brief description of the electrical circuits of the SM-2000 SWEEP/SIGNAL GENERATOR.

3-3. Refer to the appropriate schematic diagram, located in Section V, when reading principles of operation.

3-4. Figure 3-1. provides a functional block diagram of the SM-2000 main chassis and plug-in heads.

3-5. POWER SUPPLY.

3-6. The power supply furnishes the following voltages:

a. Two regulated positive voltages (175 V and 100 V).

b. One unregulated positive voltage (approximately 350 V).

c. Two regulated negative voltages (87 V and 150 V).

d. Two oppositely phased 6.3 V filament voltages with grounded reference.

e. One isolated 6.3 V filament supply operating at +100 V dc.

3-7. The power supply employs two half-wave solicon rectifier systems, one developing the positive voltages and the other the negative voltages.

3-8. The rectifier system supplying the positive voltages furnishes about +350 V to two electronic regulator pass tubes, V105 and V104. The output voltage of V105 (+175 V) is sampled. Any deviation from normal is amplified and, through phase reversal in V103A, counteracted by a change in the grid voltage of V105. The 100 V output of V104 is regulated similarly by V103B. The negative rectifier system output voltages are filtered and then stabilized to -150 V and -87 V by voltage regulator tubes V101 and V102 respectively.

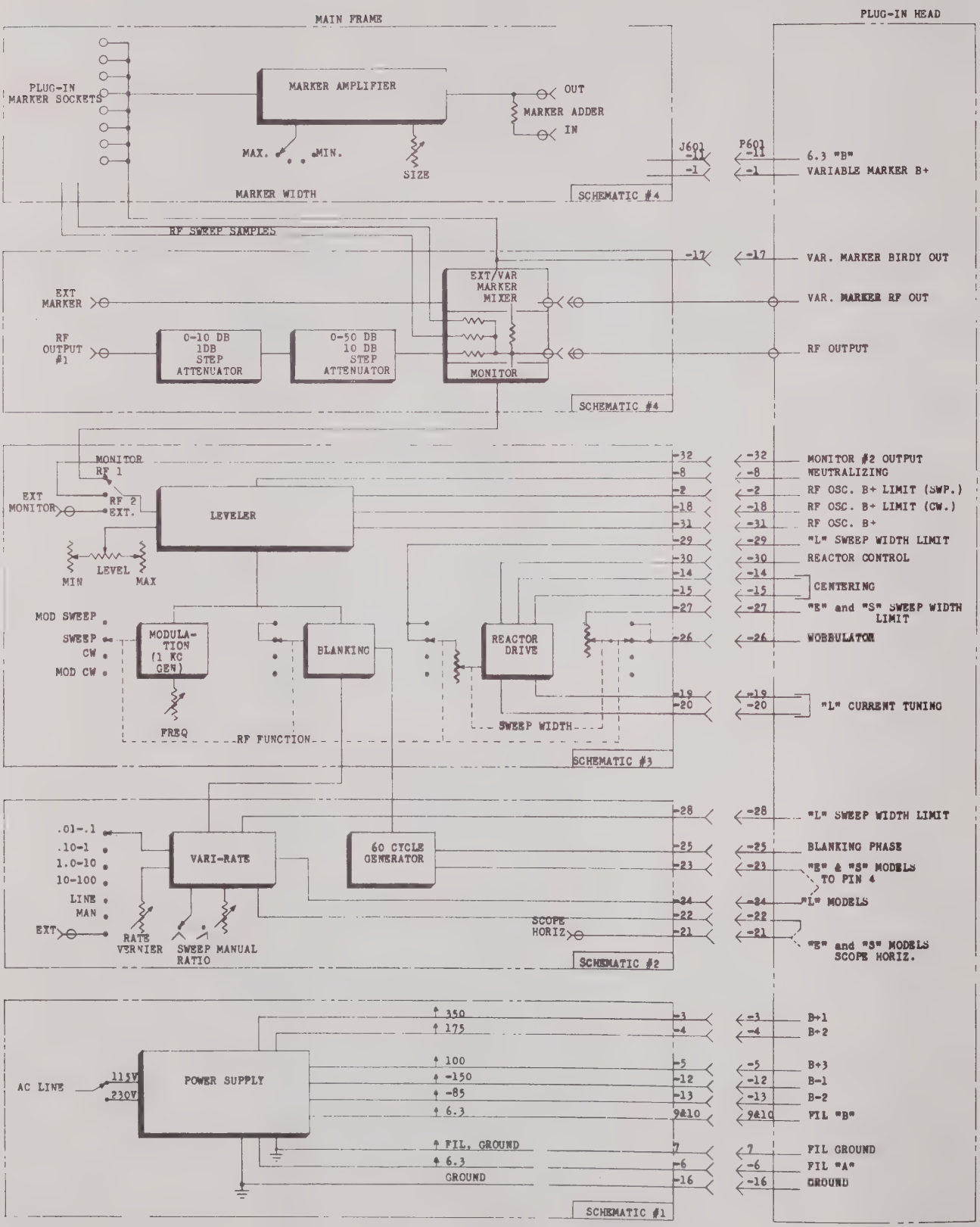

Figure 3-1. SM-2000 Functional Block Diagram

3-9. The -87 V is a stabilized power supply reference voltage only and is not a power source for any other circuit in the SM-2000. This is an extremely stable voltage because it is operating under no-load conditions and because the input to V102 is regulated by V101.

3-10. AUTOMATIC LEVEL CONTROL CIRCUITRY (ALC CIRCUIT).

3-11. The B+ supplied to some plug-ins is not controlled by this circuit. The signal from these units is leveled by internal adjustment.

3-12. A constant output level is desirable for most applications. To provide a constant level an RF monitor (diode detector) develops an ALC signal proportional to the amplitude of the RF output. This ALC signal is the input to a dc amplifier chain, or ALC circuit, which decreases the sweep oscillator B+ whenever the RF output tends to rise.

3-13. The ALC circuit is equipped to accept an ALC signal from any of three sources:

a. The SM-2000 monitor, which develops the ALC signal at the RF 1 output of the plug-in. The leveling action is applied to the RF 1 signal.

b. A monitor in the plug-in, which develops the ALC signal at the RF 2 output of the plug-in. The leveling action is applied to the RF 2 signal.

c. An external monitor, which develops the ALC signal at the input to the device under test. The leveling action is applied to the RF 1 or RF 2 signal, whichever is being supplied to the device under test.

3-14. RATE GENERATOR.

3-15. To produce the sawtooth (or triangular) voltages required for sweep drive and scope horizontal output with electronically swept plug-ins, a rectangular waveform generator and a Miller integrator are coupled in a feedback loop. The same circuit also provides a blanking signal. The sweep drive waveform is developed as discussed below.

3-16. SCHMITT TRIGGER: The Schmitt Trigger (V401B, C) is a voltage-controlled switch which produces a rectangular wave output whenever the input voltage varies over a sufficient range to switch it from grid clamp to cut-off and back again. Because of the way it is biased, the Schmitt Trigger exhibits hysteresis in that the voltage required to switch from cut-off to clamp is more positive (by about 12 V) than the voltage required to switch from clamp to cut-off.

3-17. The output of the Schmitt Trigger is squared, limited in amplitude, and set at the proper dc level by biased diodes CR401 and CR402. The rectangular wave is coupled to a Miller integrator by the cathode follower action of V402A.

3-18. MILLER INTEGRATOR (V403): As the step voltage at the cathode of V402A causes the grid voltage of V403 to begin to change, the plate instantly feeds back an opposing signal through the capacitor connected between the two elements. This feedback results in a ramp rather than a step appearing on both plate and grid and effectively multiplies the feedback capacitor by the amplification factor of the tube, allowing the ramp voltage to be developed over a smaller and much more linear portion of the exponential charge and discharge curves.

3-19. The waveform at the plate of the Miller integrator is coupled by cathode follower action to pin 6 of V402B. This signal is the sweep drive waveform for electronically swept plug-ins. It is fed to a sweep limiting control in the plug-in and back to the reactor drive circuitry in the SM-2000. The same signal also is applied across the voltage divider in the grid circuit of V401A and provides the feedback necessary to sustain oscillation in the circuit.

3-20. FREQUENCY AND AMPLITUDE: The slope of the ramp voltage is directly proportional to the peak amplitude of the rectangular wave and inversely proportional to the RC product in the integrator grid circuit. The amplitude of the rectangular wave is set by R416 and R423 or R424. The RC product is determined by the settings of R421 or R422 and the SWEEP RATE switch.

3-21. The slope of the ramp voltage determines the time required for the voltage at pin 7 of V401B to traverse the spread between switching points, and hence the frequency of the waveform. The amplitude of the output is inversely proportional to the percentage of feedback in the loop as determined by the setting of R401, which also has an effect on the frequency.

3-22. TRACE TO RETRACE RATIO: The ratio of trace to retrace time is determined by the relative amplitudes of the positive and negative portions of the rectangular wave. These amplitudes are controlled by the bias on the clipping diodes CR401 and CR402. The bias is set by R416 and R423 or R424.

3-23. BLANKING CIRCUIT.

3-24. The purpose of the blanking circuit is to produce a zero base line in the SWEEP and MOD SWEEP modes by removing B+ from the sweep oscillator during the sweep retrace.

3-25. With electronically swept plug-ins, the blanking voltage is the square wave produced in the rate generator. This square wave is fed to the blanking switch tube which turns the B+ pass tube off and on during alternate half-cycles. This procedure allows B+ to reach the sweep oscillator during forward sweep only. The sweep oscillator conducts during the negative half-cycle of the Schmitt Trigger output waveform.

3-26. Action is different in the mechanically swept units. The sweep drive is a sine wave voltage from the power transformer. A properly phased 60 Hz square wave is required for blanking. This blanking voltage is originated by squaring and

amplifying a phased 6.3-volt sine wave. This square wave controls the sweep oscillator voltage regulator tube, and thus deprives the sweep oscillator of plate voltage during one-half of each cycle. The BLANKING WIDTH control in the SM-2000 and the BLANKING PHASE control in the plug-in are provided for adjusting this blanking voltage to coincide with the horizontal and sweep drive signals.

3-27. The blanking circuit is operative in the SWEEP and MOD SWEEP positions of the RF FUNCTION Switch only.

3-28. 1kHz MODULATION.

3-29. The 1kHz square wave with which the RF output is plate-modulated in the MOD SWEEP and MOD CW modes is generated by an astable multivibrator in which the screen grid of a pentode serves as one plate. The output is electron-coupled to the pass tube from the plate of the pentode, which serves as an electronic switch to connect the control grid of the pass tube to B-I during the interval when the pentode conducts.

3-30. SWEEP DRIVE.

3-31. ELECTRONICALLY SWEPT PLUG-INS: With these models, which use a saturable reactor or varactor diodes as a sweep device, the sweep drive is derived from the output of the Miller integrator in the rate circuit.

3-32. The following discussion applies to those models which use a saturable reactor. The reactor drive circuitry for those using varactor diodes is contained in, and discussed in the manual for, the plug-in.

3-33. The "centering current" or average dc current through the control winding at maximum and minimum sweep widths is determined by the CENT MAX SWEEP (R463) and CENT MIN SWEEP (R469) controls respectively. These controls set the dc voltages at the cathodes of V301C and V402C respectively through cathode follower action and fix the dc potential at each end of the SWEEP WIDTH Control (R467), thus maintaining the proper dc level at the wiper arm regardless of the sweep width used.

3-34. The low impedances of the cathode circuits of V301C and V402C prevent interaction between R463 and R469.

3-35. The triangular or sawtooth output of the integrator is coupled through the sweep width limit control in the plug-in and the Front Panel SWEEP WIDTH control to the control grid of the reactor drive tube. Since the control winding of the saturable reactor is in the plate circuit of this tube, the instantaneous voltage at the grid determines the instantaneous current through the control winding.

3-36. E AND S MODELS: With mechanically swept plug-ins, the sweep drive to the drive motor is derived from a 6.3 V filament winding of the power transformer. This voltage is applied across a fixed and a variable (sweep width limit control) resistor in the plug-in and R471, one of the two ganged Front Panel SWEEP WIDTH controls. The amplitude of the sweep drive signal is determined by the ac voltage at the wiper arm of R741.

3-37. TURRET ATTENUATORS.

3-38. The turret attenuators provide 0-60 dB of attenuation in 1 dB steps. One provides 0-10 dB of attenuation in 1 dB steps. The other is a 0-50 dB unit with 10 dB steps.

3-39. BIRDY-BY-PASS SYSTEM.

NOTE

This system is inoperative when the plug-in contains its own fixed marker circuitry.

3-40. The Birdy-By-Pass Marker System should not be confused with crude marker systems in which the marker is produced by non-linear mixing in the device under test. In such systems, a CW source (called the marker) and whatever sweep signal happens to be within the pass band of the device under test heterodyne to to produce a video-frequency beat note, or "birdy," which suffers from these and other defects:

a. No birdy appears if either the CW or the sweep signal gets lost in detuned circuits.

b. Overloading of the device under test by a strong CW source occurs easily.

c. No shaper (width) or size (amplitude) control is provided.

3-41. To understand the birdy-by-pass system, these points must be considered:

a. How a marker is produced.

b. What a marker looks like on the scope.

c. How a marker is applied to the response signal in a typical set-up.

d. To produce a birdy type marker, two signals are required:

(1) Sweep frequency signal (sweep sample).

(2) CW frequency signal (crystal oscillator or variable oscillator).

3-42. These inputs are mixed in individual marker units which provide a heterodyne output (birdy) when the sweeping signal passes through the frequency of the CW oscillator.

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b. CW frequency signal (crystal oscillator or variable oscillator).

3-44. These inputs are mixed in individual marker units which provide a heterodyne output (birdy) when the sweeping signal passes through the frequency of the CW oscillator.

3-45. In the birdy-by-pass system of the SM-2000, the plug-in marker units are operated singly or in any combination by individual toggle switches on the Front Panel and are coupled through separate size (amplitude) controls. S509 turns on the variable marker unit, and its output, together with any external marker used, is fed directly from the marker mixer in the SM-2000 to the wiper arm of the EXT/VAR SIZE Control, ganged to S509.

3-46. The markers are amplified, shaped, and amplified again, after which the size of all markers is adjusted by a Front Panel control.

3-47. The markers are next coupled to the output jack of the MARKER ADDER section and superimposed on the demodulated RF response signal of the device under test. If the MARKER WIDTH switch is in an XY-Plot position, the markers are rectified prior to being applied to the response signal.

NOTE

In some plug-in oscillators, the variable marker oscillator output is mixed with the sweep sample in the plug-in rather than in the SM-2000. The resulting birdy is fed directly to the birdy-by-pass amplifier system instead of through the SM-2000 marker mixer in such units.

3-48. The birdy marker will appear as a narrow vertical line at wide sweep widths, but as sweep width is reduced the birdy is spread out with an amplitude peak on each side of the zero beat. This birdy shape is a video envelope which represents the band-pass response of the birdy amplifier circuit.

3-49. At frequencies higher than about 55 MHz harmonics of the fundamental oscillator frequency are used, and often a tuned circuit adjustment is provided to select one of these harmonics.

3-50. PLUG-IN MARKER TYPES:

a. "C" Single Frequency Type

b. "CH" Harmonic Type

c. "CDH" Extended Harmonic Type

3-51. GENERAL DESCRIPTION.

3-52. EXTERNAL MARKER INPUT: The CW signal from the external marker input is fed into a diode mixer and mixed with a sample of the sweep signal to produce a birdy which is then fed into the birdy-by-pass amplifier through R511.

3-53. GENERAL DESCRIPTION OF THE PLUG-IN MARKER BOXES: A plug-in marker box contains a sweep sample input and output, an oscillator, a mixer, and birdy output connection (at the plug-in base). The CW oscillator signal is self-contained and crystal-controlled. The sweep sample input is introduced at a BNC connector (from the sweep oscillator) and leaves through a short piece of coaxial cable to enter another plug-in marker box or to be terminated through a 50-ohm resistor to ground. For fuller information than that presented here, see the manuals for the individual marker units. Plug-in markers are not used with plug-in oscillators having self-contained fixed marker circuitry.

3-54. MIXER CIRCUITS USED IN PLUG-IN MARKERS: The mixer circuits used in single-frequency marker units consists of a diode mixer with an input circuit tuned to the frequency of the desired marker. This circuit rejects all sweep frequencies except the desired marker frequency. This tuned circuit is omitted in the HARMONIC TYPE plug-in marker boxes, since markers at many sweep frequencies are desired.

3-55. OSCILLATOR CIRCUITS USED IN PLUG-IN MARKERS: Because of the wide range of frequencies at which markers are needed, a single type oscillator circuit is not suitable. The two basic types used are:

a. PIERCE OSCILLATOR CIRCUIT 0-12.5 MHz: Uses parallel-resonant crystal, requires no tuning adjustment.

b. OVERTONE OSCILLATOR CIRCUIT ABOVE 12.5 MHz: Uses series-resonant crystal, requires tuning adjustment.

NOTE

This circuit oscillates at a fundamental frequency determined by a high order mode of the crystal. Tuning selects the proper crystal mode.

3-56. The SM-2000 has provisions for a maximum of eight single frequency (C Type) crystal markers, eight harmonic (CH Type) crystal markers, four harmonic (CDH Type), or any combination. Each CDH type marker occupies the same space as two C or CH units.

3-57. TYPE C.

3-58. These markers provide a single marker at a selected frequency. There are variations in circuitry for two reasons:

a. Wide frequency range over which markers are needed.

b. Need for narrow birdies at low frequencies.

3-59. By tuning the sweep sample coupling circuit, the sweep frequency which enters the diode mixer circuit can be varied to reject unwanted markers generated from other harmonics of the crystal oscillator. The amplitude of the birdy can be varied by adjusting the sweep coupling loop position.

3-60. HARMONIC TYPE CH AND CDH.

3-61. These provide birdy markers at evenly spaced frequency intervals at harmonics of the oscillator frequency used. The CDH type; which occupies two marker sockets, covers a very broad range. High order harmonics of the oscillator frequency are generated in a one-or two-diode mixer circuit.

3-62. INSTALLATION OF PLUG-IN MARKERS.

3-63. These plug-in units can be inserted in any one (or two) of the eight plug-in sockets on the SM-2000. The sweep sample input (BNC jack) can be fed from either one of the two sweep sample lines in the unit or from the sweep sample output of an adjacent plug-in unit. The sweep sample output (BNC plug) should be connected to either one of the BNC terminators on the chassis or the sweep sample input of an adjacent box, to provide a 50-ohm matched termination.

3-64. Correct operating voltages are supplied to the sockets from the SM-2000 chassis.

3-65. VARIABLE MARKERS.

3-66. Variable markers, if supplied, are contained in the plug-in units and are discussed in the manuals for the individual oscillators.

SECTION IV

MAINTENANCE

4-1. GENERAL.

4-2. This section provides complete information for troubleshooting and maintenance of the SM-2000 SWEEP/SIGNAL GENERATOR.

4-3. Maintenance of any electronic equipment requires the application of common rules of trouble-shooting, such as checking for charred resistors, component damage, open filaments, and glowing anodes. Further procedures are presented below with the assumption that thest checks have been made.

4-4. In addition to these rules, this manual simplifies trouble-shooting with a refinement which provides a quick tie-in of the block diagram with the schematic. (Refer to page 3-2).

4-5. The block diagram of the SM-2000, is divided into "compartments" representing each of the five schematic diagrams. At the right side of each compartment is shown the numbers of the pins (on the 32-contact jack and plug which inter-connect the control chassis and the plug-in unit) associated with each function in that compartment.

4-6. A recommended maintenance procedure taking advantage of this layout, with a sample mulfunction, follows:

a. Determine the apparent source of the trouble from the nature of the malfunction. For example, no 1 kHz modulation in the MOD modes would indicate possible failure of the 1 kHz generator, particularly if blanking is still present in the SWEEP modes.

b. Locate the functional block concerned on the block diagram. The 1 kHz generator is seen to be in the compartment representing schematic number 3.

c. Fold out the schematic for the compartment containing the block.

d. Locate the circuitry for the particular function on the schematic diagram. The 1 kHz generator is seen to be near the lower left corner of schematic number 3.

e. Check the circuit components to locate the trouble. If V405 is found to be defective, the sample trouble probably has been located.

4-7. TEST EQUIPMENT.

4-8. The following test equipment will be required to perform maintenance and alignment of the SM-2000.

a. Accurate 20-kilohm/v d-c voltmeter or vacuum-tube voltmeter.

b. Good quality d-c oscilloscope with input impedance of 1 megohm or more.

c. RF detector suitable for frequency range of plug-in oscillators used (see our literature for recommended detectors).

d. Plug-in oscillator employing electronic sweep.

f. Amphenol plug type 26-4100-32P with pins 14 and 15 shorted, pins 19 and 20 shorted, a heavy 1" wire lead connected to pin 4, a 680-ohm two-watt resistor connected to pin 30, a 39-kilohm (±1%) half-watt resistor connected between pins 5 and 29, and a 100-kilohm (±1%) half-watt resistor connected between pins 29 and 16. This plug, properly wired, may be ordered from Telonic Instruments as MODEL TPS-39.

g. Straight probe for oscilloscope vertical input.

h. Accurate d-c milliammeter, capable of accurate reading in the 18-20 mA range.

4-9. PERFORMANCE CHECK. (Refer to figure 4-1.)

4-10. This performance check may be used as a routine maintenance procedure or as an incoming inspection to verify the performance of the SM-2000.

4-11. PRELIMINARY INSTRUCTIONS.

a. Set up the equipment in a system similar to that shown on page 2-1, omitting the device under test. Observe the instructions on page 2-2 regarding type of cable and impedance matching.

b. Check the position of S102 (see description below), connect the SM-2000 to the proper line voltage, and turn on the power.

c. Check to see that V101 and V102 are fired before proceeding.

d. Do not plug in an oscillator at this time.

4-12. POWER SUPPLY.

4-13. S102 (115/230 V switch). This switch connects the primaries of the power transformer in parallel aiding for 115 V operation and in series aiding for 230 V operation. It must be set to the position which corresponds to the line voltage available.

4-14. NEGATIVE VOLTAGE.

4-15. Although there is no adjustment for these voltages, the stability of the positive voltage depends on the stability of the reference voltage established by V101 and V102 and the adjustment ranges of the B+2 and B+3 control circuits depend on the actual value of this reference, nominally -87 V. For these reasons both B-1 and B-2 should be checked each time the power supply is adjusted.

4-16. Connect the voltmeter from J601-13 (B-2) to ground. The voltage read should be about -87 V.

4-17. Connect the voltmeter from J601-12 (B-1) to ground. The voltage read should be about -150 V. If either voltage is unstable or outside the voltage range specified by the tube manufacturer, or if either tube is not fired, replace the tube(s). If the trouble persists, check for other trouble in the power supply. If the readings are normal, proceed with the B+2 and B+3 adjustments.

4-18. B+2 (R110). Connect the voltmeter from J601-4 to ground. Adjust R110 for a reading of +175 V.

4-19. B+3 (R121). Connect the voltmeter from J601-5 to ground. Adjust R121 for a reading of +100 V.

4-20. VARIABLE-RATE CIRCUIT.

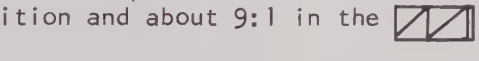
4-21. When the six internal controls in the variable rate circuit are properly adjusted, the following conditions pertain:

a. The circuit oscillates, producing a triangular waveform.

b. The waveform is of the proper amplitude (100 volts peak-to-peak).

c. The waveform is at the proper average d-c level (+70 volts).

d. The "trace" and "retrace" portions of the waveform are of the proper duration as determined by the rate selected.

e. The duration of the trace and retrace portions of the waveform are in the proper ratio (1:1 in the position and about 9:1 in the  position of the sweep ratio switch).

4-22. The six controls which affect the operation of this circuit in one or more ways are:

a. R401--TRIGGER BIAS

b. R404--TRIGGER AMPLITUDE

c. R416--RETRACE PERIOD

d. R422--LINE SIZE

e. R423-- SWEEP PERIOD

f. R424-- SWEEP PERIOD

4-23. Since there is interaction between several of these controls, the adjustment procedure is presented here as an integrated technique which results in all six controls being correctly adjusted.

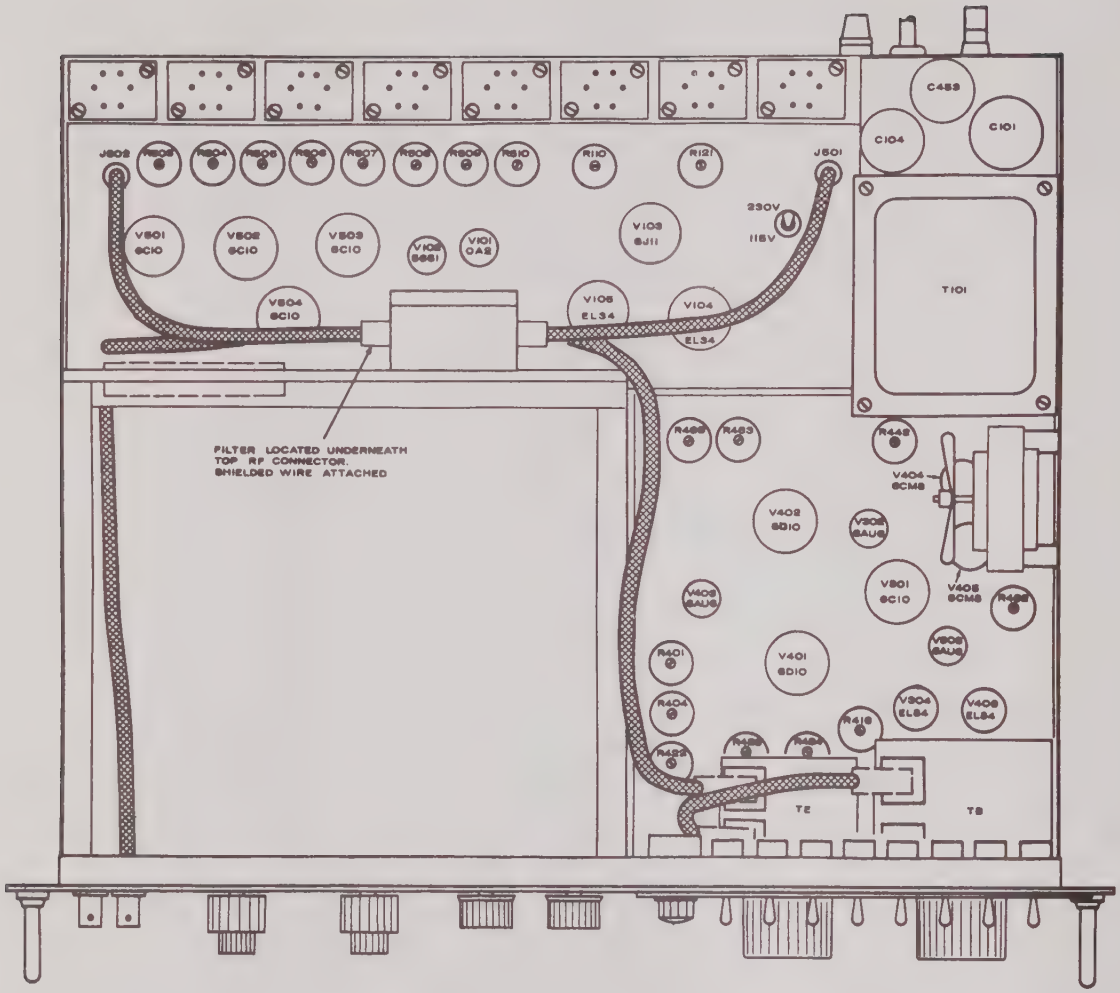


Figure 4-1. SM-2000 Chassis Layout (Top View)

4-24. With the power off, preset the following Front Panel controls:

a. RF FUNCTION switch to SWEEP

b. SWEEP RATIO to

c. SWEEP WIDTH fully counter-clockwise

d. SWEEP RATE to 10-100

e. MANUAL/VERNIER knob fully clockwise

f. LEVEL MIN fully counter-clockwise

g. LEVEL fully counter-clockwise

h. MONITOR switch to RF 1

4-25. Set the oscilloscope controls for a 10-cm 20-millisecond horizontal scale (2 milliseconds per centimeter) and a 20 V/cm vertical scale.

4-26. Plug in an oscillator of the electronically swept type. Connect the probe to J601-28. Turn on the power.

4-27. The remainder of the adjustment procedure for the variable rate circuit is divided into Parts A and B. If a triangular waveform is present at this point omit Part A and perform the adjustments in Part B only.

4-28. Part A: Preset the following internal controls:

a. Both SWEEP PERIOD controls to mid-range

b. RETRACE PERIOD to mid-range

c. TRIGGER AMPLITUDE fully counter-clockwise

d. TRIGGER BIAS fully counter-clockwise

4-29. The oscilloscope should indicate a d-c potential of about +150 V. Turn the TRIGGER BIAS control clockwise until the neon bulbs nearby start to glow. The d-c potential at J601-28 should drop to about +5 V. Turn the TRIGGER BIAS control counter-clockwise until the neon lamps just go out. The d-c voltage at J601-28 should return to +150 V. Now turn the TRIGGER AMPLITUDE control clockwise until the bulbs begin to glow again. A triangular waveform should appear on the oscilloscope. (Refer to figure 4-2.)

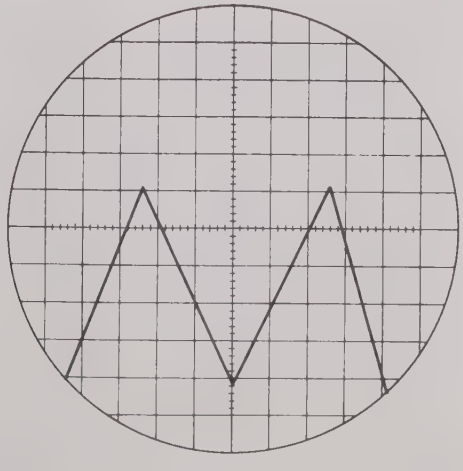


Figure 4-2. Typical Triangular Waveform

4-30. If the neon bulbs fail to go out when the TRIGGER BIAS control is fully counter-clockwise, leave it in this position and turn the TRIGGER AMPLITUDE control clockwise while observing the oscilloscope until a triangular waveform appears.

4-31. Part B: Adjust TRIGGER BIAS for a d-c level (half-way between peaks) of +70 V. Adjust TRIGGER AMPLITUDE for 100 V peak-to-peak waveform. Since these two controls interact, readjustment of each may be necessary before the waveform is at both the proper amplitude (100 volts peak-to-peak) and the proper d-c voltage (+70 V). Unless the oscilloscope is known to be calibrated accurately on this scale the d-c level should be verified with a good quality d-c voltmeter having a high input impedance. The voltmeter must be "average-responding"; i.e., the meter must respond to the average d-c level of the waveform.

4-32. Adjust SWEEP PERIOD for a 5-millisecond duration of the positive-going portion of the waveform. Adjust RETRACE PERIOD for a 5-millisecond duration of the negative-going portion of the waveform.

4-33. Set the Front Panel SWEEP RATE switch in the LINE position. Adjust LINE SIZE for a 100-volt peak-to-peak waveform.

4-34. Return the SWEEP RATE switch to the 10-100 position and set the Front Panel SWEEP RATIO switch to the position. Adjust SWEEP PERIOD to provide a 10-millisecond total duration of the sawtooth cycle. (Refer to figure 4-3.)

4-35. REACTOR DRIVE.

4-36. As the Front Panel SWEEP WIDTH control is varied between maximum and minimum sweep widths, it is necessary that the d-c potential at the w per arm be closely controlled, as this voltage determines the average, or "centering," current through V406, the reactor drive tube. This is determined at maximum and minimum sweep widths by the settings of R463 and R469 (CENT MAX SWEEP and CENT MIN SWEEP) respectively. The proper settings will provide slightly more centering current at maximum sweep width then at minimum, as most plug-ins operate more satisfactorily under this condition.

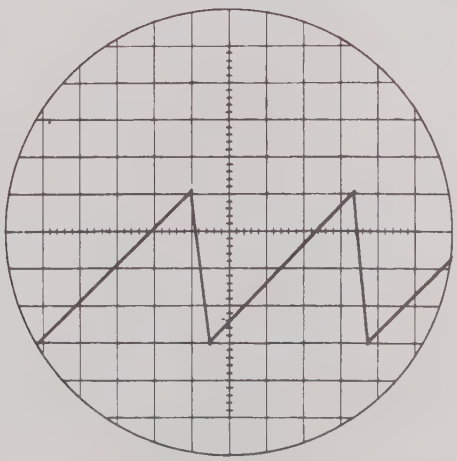


Figure 4-3. Typical Sawtooth Waveform

4-37. With the SM-2000 power OFF, insert the "dummy" Amphenol 26-4100-32P plug in the 32-contact socket, J601. The wiring of this plug is described under EQUIPMENT REQUIRED in this section. Connect the ammeter between Pin 4 and the resistor connected to Pin 30. MAKE SURE THE AMMETER REMAINS CONNECTED AT ANY TIME THE POWER IS ON.

4-38. Preset the following Front Panel controls:

a. SWEEP WIDTH fully counter-clockwise

b. SWEEP RATIO to

c. RF FUNCTION switch to SWEEP

d. SWEEP RATE to 10-100

e. LEVEL fully counter-clockwise

f. MONITOR to RF 1

4-39. Before proceeding with the adjustment of R463 and R469 turn on the power, allow a 15-minute warmup period, and check the B+3 voltage again. It should be set to exactly +100 V using the most accurate measuring standard available.

4-40. After B+3 is set correctly, adjust CENT MIN SWEEP (R469) for a reading of 18 mA on the ammeter. Rotate SWEEP WIDTH fully clockwise and adjust CENT MAX SWEEP (R463) for a reading of 20 mA on the ammeter.

4-41. Turn off the power, remove the dummy plug, plug in an oscillator, and reconnect the setup as in the figure on Page 2-1, omitting the device under test. Turn on the power.

4-42. MODULATION CIRCUIT.

4-43. The frequency of the 1kHz square wave with which the output is modulated in the MOD SWEEP and MOD CW modes is determined by the RC time of the coupling capacitors in series with R451 and R452. R452 is a coarse frequency control, which is set to bring the desired 1kHz modulation frequency to approximately the mid-range position of R451, the vernier Front Panel control.

4-44. Preset MOD FREQ VERNIER (R451) on the Front Panel to mid-range and the RF FUNCTION Switch to MOD CW.

4-45. Connect the probe from the vertical input of the oscilloscope to J601-31.

4-46. Adjust R452 (MOD FREQ LIMIT) for exactly 20 cycles on the scope (two cycles per centimeter).

4-47. 60 Hz GENERATOR (Used with Mechanical Sweep Drive Only).

4-48. The BLANKING PHASE Control in the mechanically swept plug-ins and C413 in

the SM-2000 form an a-c voltage divider and phase shifting network. The phase of the signal fed to the grid of V404A is determined by the setting of the BLANKING PHASE Control. This setting is covered in the manuals for the individual plug-ins.

4-49. The bias on V404A is set by adjusting R442, BLANKING WIDTH. The proper bias provides approximately equal periods for the negative and positive portions of the squared out-put.

4-50. A mechanically swept plug-in oscillator must be used in adjusting the BLANKING WIDTH control.

4-51. Preset the following controls:

a. RF FUNCTION to SWEEP

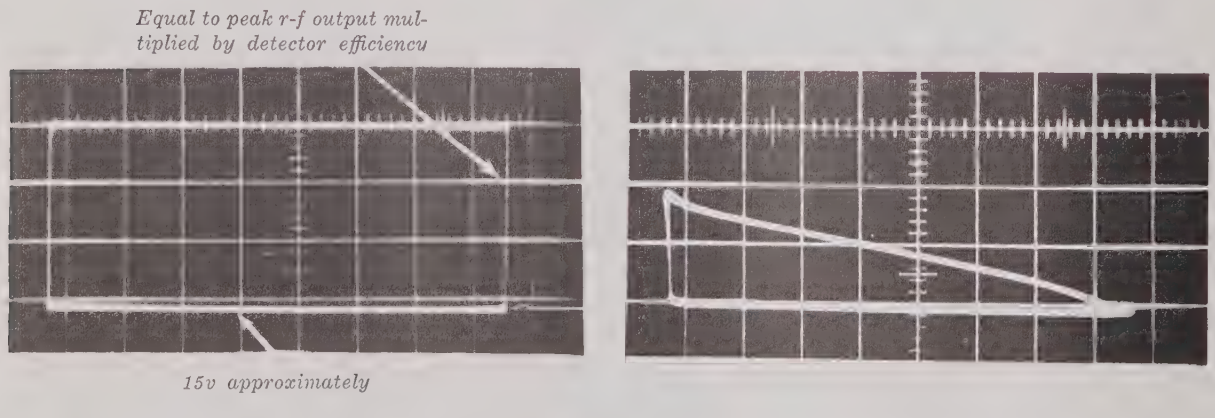
b. MONITOR to RF 1

c. LEVEL Control fully clockwise

d. Attenuators both in 0 dB position

e. Oscilloscope controls for externally-supplied horizontal deflection voltage

4-52. Connect the RF 1 (or RF 2) output through an RF detector to the vertical input of the scope. A rectangular pattern should appear. The upper right corner may be rounded, depending on the characteristics of the detector diode. (Refer to figure 4-4., View A.)



View A (Properly Adjusted) View B (Misadjusted)

Figure 4-4. Blanking Waveform

4-53. Adjust scope vertical and horizontal sensitivity controls to present a pattern as shown. Pattern will deflect up or down depending on output polarity of the RF detector. Patterns shown are with Telonic half-wave detector having a negative output. A vertical line indicates no horizontal output. First check the oscilloscope and connecting cables, then trouble-shoot the horizontal sweep section.

4-54. A horizontal line with zero amplitude indicates no RF out-put. First check the oscilloscope, RF detector, level controls, and connecting cables. Then trouble-shoot.

4-55. A horizontal line deflected below zero indicates no blanking. Trouble-shoot the 60-cycle blanking generator. If pattern is not rectangular, adjust BLANKING WIDTH.

4-56. The MARKER SIZE Controls (R503 through R511) set the amplitude of the individual marker signals at the input to the birdy-by-pass amplifier system. They are set for optimum viewing of each marker. Perhaps the most common adjustment procedure would be that which results in equal amplitude for all markers, but these controls allow for emphasis of individual markers.

4-57. TROUGLESHOOTING PROCEDURE.

4-58. Tables 4-1. thru 4-3. provide information useful in troubleshooting the SM-2000.

TABLE 4-1.

SM-2000 Trouble Shooting Chart #1				
SYMPTOM	CHECK (ON J601)	IF RESULT IS	TROUBLE PROBABLY IN PLUG-IN	TROUBLE PROBABLY IN SM-2000
Weak or no output or unleveled output	DC voltage at Pin 31 with RF LEVEL fully clockwise	High (see values in oscillator manual)	X	
		Low or zero		X
		NOTE: Trouble probably in plug-in if output not level with "LA" series.		
RF 2 output not leveled ("E" Models only)	RF 1 output	Leveled RF 1 output	X	
		RF 1 output not level		X
No sweep width	With "L" Models: 1. Voltage across R473	Sawtooth or triangular waveform	X	
		OV or DC voltage	Inconclusive. See check #2	
	2. Resistance between Pins 14 and 15, 28 and 29, 30 and 4.	Open on any check	X	
		Continuity		X
	With "E" and "S" Models: Resistance between Pins 27 and 9, 26 and 27, 26 and ground.	Open between 27 and 9	X	
		26 and 27		X
		26 and ground	X	
Changing sweep width changes center frequency	With "L" Models: Resistance between Pins 29 and 5, 28 and 5, 29 and ground.	Open on any check	X	
		Continuity		X
	With "E" and "S" Models, the frequency range above and below the dial setting normally will be unequal except at narrow sweep widths. With oscillators which are current-tuned, a change in center frequency with a change in sweep width is normal.			

TABLE 4-1. (Cont)

SYMPTOM	CHECK (ON J601)	IF RESULT IS	TROUBLE PROBABLY IN	
			PLUG-IN	SM-2000
No variable marker (Plug-in marker present)	1. For birdy at Pin 17	Birdy present		X
		No birdy	Inconclusive. See Check #2	
	2. DC voltage at Pin 1	100 V	X	
		Low or no voltage		X

4-59. The following chart is prepared to assist in locating those troubles which the previous chart indicates may be in the control chassis:

TABLE 4-2.

SYMPTOM	CHECK
Weak or no output-	Supply voltages (if low check power supply circuit beginning with V102). See block diagram for J601 pin numbers at which the voltages can be checked. Check leveler circuit. Check V304, V404B and associated circuitry.
Unleveled output-	Monitor diode (CR202); V301-V303 and associated circuits.
No sweep width-	With "L" Models: Horizontal deflection voltage at J601-21. If present, check V301C, V402C, V406, and associated circuitry. If not, calibrate vari-rate circuit. If the circuit cannot be calibrated, trouble-shoot the vari-rate circuit. With "E" and "S" Models: If open between Pins 26 and 27, check R471 and S403-2B. If not, look for trouble in "B" phase filament circuit.
Changing sweep width also changes center frequency-	With "L" Models: Recheck calibration of R469 and R463. Check V402 and associated components.
No variable Marker-	If plug-in markers are present, check monitor-marker mixer box and leads (particularly CR201). If no plug-in markers are present, check V504 and associated circuits.

4-60. The following table lists additional troubles which probably are due to malfunctions in the chassis.

TABLE 4-3.

SYMPTOM	CHECK
No blanking, or incomplete blanking (1kHz modulation normal) blanking on CW modes -	V404 and associated circuitry. S403-1C.

TABLE 4-3. (Cont)

No 1kHz modulation; less than 100% modulation; 1kHz modulation in SWEEP and CW modes (normal blanking)-	Check V303, V304, V404, and associated circuit components. Check S403-1B. Recalibrate R452.
No 1kHz modulation and no blanking-	CR301 for short or reversed polarity. V303, V304, and associated circuitry.
Sweep rate wrong-	Vari-rate circuit. Recalibrate R416, R421, R423, R424. Check S401.
Blanking phase and/or width wrong-	Recalibrate R442. Check V404A and associated circuitry.
Insufficient sweep width-	V402, V406 and associated circuitry.
Some, but not all, markers missing-	Check V501, V502, or V503 as appropriate. Check S501-508.
Excessive or no horizontal deflection voltage ("L" Models), normal sweep width-	R429, R430 NOTE: With normal filament voltage, and with leads intact, this trouble with "E" and "S" models probably is in the plug-in rather than the control chassis.

4-61. CHASSIS MOUNTING INSTRUCTIONS. (Refer to figures 4-5. and 4-6.)

4-62. Unit has Front Panel slotted or drilled for standard RTMA Mounting. Position unit in rack and install mounting screws in holes marked 1.

4-63. Dust cover removal:

a. Remove four #8-32 thread-cutting screws, marked 2 (two on each side).

b. Lift off cover for easy access to chassis.

4-64. To remove chassis from cabinet:

a. Remove the four #10-32 screws (marked in front view). These screws hold the panel to the cabinet.

b. Slide chassis out of cabinet by pulling forward on the two Front Panel handles.

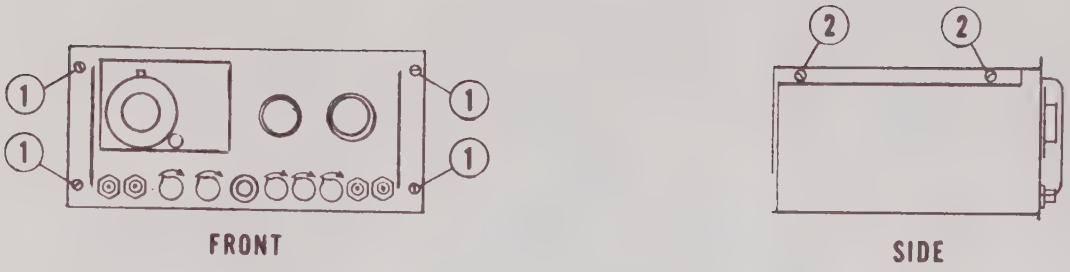


Figure 4-5. RACK MOUNTED UNIT

4-65. To replace chassis in cabinet:

a. Insert the flanges on the bottom of the chassis side panels into the slot of the cabinet guide rails.

b. Push chassis back into cabinet.

c. Replace the four #10-32 screws in the front panel.

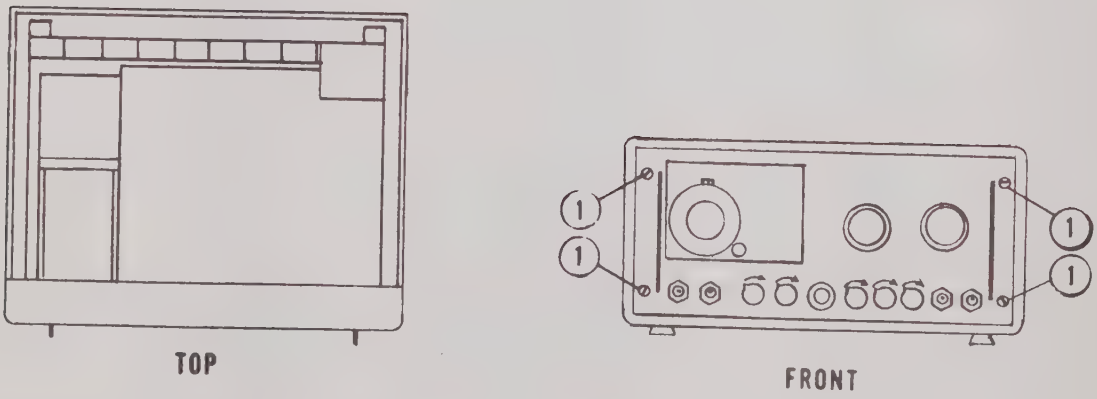


Figure 4-6. CABINET MOUNTED UNIT

SECTION IV

PARTS LIST AND SCHEMATIC DIAGRAMS

5-1. GENERAL.

5-2. This section provides the complete electrical parts list, component numbering system, and a complete set of schematic diagrams required for maintenance of the SM-2000 SWEEP/SIGNAL GENERATOR CONTROL CHASSIS.

5-3. COMPONENT NUMBERING SYSTEM. Table 5-1. specifies the numbering sequence used for each circuit board in the SM-2000.

TABLE 5-1.

Numbering Sequence	
101-199	Power Supply
201-299	Monitor, Mixer, Attenuators
301-399	Leveler
401-499	Horizontal and Sweep Drive Circuit
501-599	Plug-in Markers and Marker Amplifier
601-699	Interconnections between Control Chassis and Oscillator

5-4. ABBREVIATION CODE.

5-5. Table 5-2. specifies the abbreviations used for components in the SM-2000 parts list.

TABLE 5-2.

ABBREVIATION CODE	
ARTJ	Assembly, Resistive Terminator Jack
ASW	Assembly, Switch
CFC	Capacitor, fixed, ceramic
CFCF	Capacitor, fixed, ceramic feed-thru
CFE	Capacitor, fixed electrolytic
CFM	Capacitor, fixed, mica
CFMB	Capacitor, fixed, mica, button type
CFMY	Capacitor, fixed, mylar
CFP	Capacitor, fixed, paper
DS	Diode, semi-conductor
IF	Inductor, fixed
JC	Jack, cable

TABLE 5-2. (Cont)

LG	Lamp, Glow
LI	Lamp, Incandescent
PC	Plug, cable
RDVW/C	Resistor, dual, variable, wirewound/ composition
RFC	Resistor, fixed, composition
RFCF	Resistor, fixed, composition, film type
RFW	Resistor, fixed, wirewound
RJ	Receptacle, Jack
RVC	Resistor, variable, composition
SWT	Switch, toggle
SC	Subject to change
TC	Terminator, cable
TE	Tube, electron

5-6. ELECTRICAL PARTS LIST.

5-7. Table 5-3. provides the complete electrical parts list for the SM-2000.

TABLE 5-3.

Electrical Parts List

Circuit Reference No.	Description	Telonic Part No.
C101	CFE, 80/10/10µf, 450 VDCW	20-0019-01
C102	CFP, 0.22µf, ±20%, 400 VDCW	22-0102-01
C103	Same as C102	
C104	CFE, 50µf, 450 VDCW	20-0018-02
C105	CFP, 0.1µf, ±20%, 400 VDCW	22-0097-01
C106	CFP, 0.1µf, ±20%, 200 VDCW	22-0093-01
C107	Same as C104	
C108	CFE, 100µf, 450 VDCW	20-0050-01
C109	Same as C108	
C110	Same as C108	
C111	Same as C108	
C201	CFC, 1000pf, ±20%, 500 VDCW	22-0004-01
C202	CFC, 470pf, GMV, 1000 VDCW	21-0015-01
C203	CFMB, 500pf, ±10%, 500 VDCW	21-0015-02
C204	CFMB, 300pf, ±10%, 300 VDCW	22-0011-01
C205	CFC, 5000pf, +80-20%, 500 VDCW	22-0002-02
C301	CFC, 50pf, ±10%, 1000 VDCW	22-0002-02
C302	Same as C301	
C401	Same as C301	
C402	CFP, 2.2µf, ±5%, 200 VDCW	22-0015-01
C403	CFMY, 0.22µf, ±10%, 200 VDCW	22-0014-02

TABLE 5-3. (Cont)

Circuit Reference No.	Description	Telonic Part No.
C404	CFMY, 0.022μf, ±10%, 200 VDCW	22-0014-03
C405	CFMY, 2000pf, ±5%, 500 VDCW	22-0087-01
C406	CFM, 150pf, ±5%, 500 VDCW	22-0018-01
C407	CFM, 200pf, ±10%, 500 VDCW	22-0008-12
C408	CFMY, 4000pf, ±10%, 600 VDCW	22-0012-01
C409	CFMY, 0.04μf, ±10%, 400 VDCW	22-0012-06
C410	CFMY, 0.2μf, ±10%, 200 VDCW	22-0012-05
C411	Same as C410	
C412	CFM, 3300pf, ±10%, 500 VDCW	22-0008-05
C413	Same as C102	
C414	CFP, 0.1μf, ±20%, 400 VDCW	22-0097-01
C415	Same as C414	
C416	CFC, 120pf, ±10%, 1000 VDCW	22-0002-03
C451	CFM, 2000pf, ±5%, 5000 VDCW	22-0087-01
C452	Same as C451	
C453	CFE, 30μf, 250 VDCW	20-0010-01
C454	CFC, 0.02μf, +80-20%, 500 VDCW	22-0007-01
C455	CFD, 150pf, ±5%, 500 VDCW (SC)	22-0018-01
C501	CFC, 1000pf, GMV, 1000 VDCW	22-0005-01
C502	CFC, 0.01μf, +80-20%, 500 VDCW	22-0006-01
C503	CFC, 5000pf, +80-20%, 500 VDCW	22-0011-01
C504	Same as C503	
C505	Same as C503	
C506	Same as C503	
C507	Same as C501	
C508	CFC, 470pf, GMV, 1000 VDCW	22-0004-01
C509	Same as C508	
C510	Same as C501	
C511	Same as C503	
C512	Same as C416	
C513	Same as C501	
C514	Same as C501	
C515	Same as C502	
C516	CFC, 200pf, ±10%, 1000 VDCW	22-0003-04
C517	Same as C502	
CR101	DS, 1N2094 or equivalent	41-0006-01
CR102	Same as CR101	
CR103	Same as CR101	
CR104	Same as CR101	
CR201	DS, 1N82 Miniature or equivalent	41-0015-01
CR202	DS, HD-5003 or equivalent	41-0014-01
CR203	Same as CR202	
CR204	Same as CR201	

TABLE 5-3. (Cont)

Circuit Reference No.	Description	Telonic Part No.
CR301	Same as CR101	
CR401	Same as CR101	
CR402	Same as CR101	
CR403	Same as CR101	
CR404	Same as CR101	
CR405	Same as CR101	
CR501	DS, 1N34A	41-0008-01
F101	3a for 115v Slow Blow	36-0016-02
	1.5a for 230v Slow Blow	33-0016-02
I101	L1, #47	36-0019-01
I401	LG, NE-2H	36-0024-01
I402	Same as I401	
J201	TC, MX-1684A/U	44-0048-01
J202	Same as J201	
J203	Same as J201	
J204	RJ, UG-625/U	44-0007-01
J205	Same as J204	
J206	Same as J204	
J207	Part of Z202	
J208	Part of Z202	
J209	Part of Z201	
J210	Part of Z201	
J211	JC	44-0010-01
J212	Same as J211	
J301	RJ	44-0010-01
J401	Post, Binding	09-1512-02
J402	Same as J301	
J501	ARTJ	44-0020-01
J502	Same as J501	
J503	Same as J301	
J504	Same as J301	
J601	Socket, 32-Contact	44-0138-01
P201-P203	Not assigned	
P204	PC, UG-88B/U	44-0028-01

TABLE 5-3. (Cont)

Circuit Reference No.	Description	Telonic Part No.
P205-P206	Not assigned	
P207	Same as P204	
P208	Same as P204	
P209	Same as P204	
P210	Same as P204	
P501	Same as P204	
P502	Same as P204	
L501	IF, 10.7h	32-0007-01
L502	Same as L501	
R101	RFC, 120kΩ, ±10%, 2W	28-0060-01
R102	RFC, 20KΩ, ±5%, 2W	28-0058-01
R103	RFC, 1MΩ, ±10%, 1/2W	26-0031-01
R104	RFC, 100Ω, ±10%, 1/2W	26-0015-01
R105	RFC, 33KΩ, ±10%, 2W	28-0059-01
R106	RFC, 100Ω, ±10%, 1W	28-0020-01
R107	Same as R104	
R108	RFC, 33Ω, ±10%, 1/2W	26-0012-01
R109	RFC, 180KΩ, ±5%, 1W	28-0012-01
R110	RVC, 25KΩ, ±30%, 0.2W	29-0044-01
R111	RFC, 82KΩ, ±5%, 1/2W	26-0100-01
R112	RFC, 180KΩ, ±10%, 2W	28-0061-01
R113	Same as R105	
R114	Same as R103	
R115	Same as R104	
R116	RFC, 27KΩ, ±10%, 2W	28-0049-01
R117	Same as R106	
R118	Same as R104	
R119	Same as R108	
R120	RFC, 100KΩ, ±5%, 1W	28-0019-01
R121	Same as R110	
R122	Same as R111	
R123	RFC, 4.7Ω, ±10%, 1W	28-0007-01
R124	RFW, 2.7KΩ, ±5%, 5W	29-0090-01
R126	RFC, 15KΩ, ±10%, 1/2W	26-0066-01
R127	RFC, 100KΩ, ±10%, 1/2W	26-0028-01
R128	Same as R123	
R129	RFW, 100Ω, ±5%, 10W	28-0114-01
R130	Same as R129	
R201	RFC, 220Ω, ±5%, 1/2W	26-0007-01
R202	RFC, 51Ω, ±5%, 1/2W	26-0003-01
R203	Same as R202	
R204	Same as R202	

TABLE 5-3. (Cont)

Circuit Reference No.	Description	Telonic Part No.
R205	RFC, 1.2KΩ, ±5%, 1/2W	26-0134-01
R206	RFC, 1KΩ, ±5%, 1/4W	26-1519-01
R207	Same as R206	
R208	RFCF, 49.9Ω, ±1%, 1/2W	27-2520-01
R209	Same as R201	
R210	RFC, 560Ω, ±5%, 1/2W	26-0088-01
R211	RFC, 10KΩ, ±5%, 1/4W	26-1513-01
R301	Same as R127	
R302	RFC, 62KΩ, ±5%, 1W	28-0036-01
R303	RVC, 25KΩ, ±30%, 0.2W	29-0024-01
R304	Part of S301	
R305	Same as R303	
R306	RFC, 10KΩ, ±10%, 1/2W	26-0023-01
R307	Same as R127	
R308	Same as R103	
R309	RFC, 39KΩ, ±10%, 1/2W	26-0026-01
R310	RFC, 180KΩ, ±10%, 1/2W	26-0045-01
R311	RFC, 10KΩ, ±10%, 1W	28-0014-01
R312	RFC, 470KΩ, ±10%, 1/2W	26-0073-01
R313	Same as R104	
R314	Same as R104	
R315	Same as R127	
R316	RFC, 2.7KΩ, ±5%, 1/2W	26-0106-01
R317	RFC, 1.8KΩ, ±5%, 1/2W	26-0131-01
R318	RFC, 75KΩ, ±5%, 1W	28-0030-01
R401	RVC, 500KΩ, ±30%, 0.2W	29-0015-08
R402	Same as R310	
R403	RFC, 330KΩ, ±10%, 1/2W	26-0094-01
R404	RVC, 100KΩ, ±30%, 0.2W	29-0015-07
R405	RFC, 220KΩ, ±10%, 1/2W	26-0044-01
R406	Same as R310	
R407	Same as R127	
R408	Same as R405	
R409	Same as R127	
R410	Same as R403	
R411	Same as R309	
R412	Same as R103	
R413	RFC, 680KΩ, ±10%, 1/2W	26-0030-01
R414	Same as R413	
R415	RFC, 1.5Mp, ±10%, 1/2W	26-0032-01
R416	RVC, 200KΩ, ±30%, 0.2W	29-0015-01
R417	Same as R403	
R418	Same as R403 (SC)	
R419	Same as R312	
R420	RFC, 620KΩ, ±10%, 1/2W (SC)	26-0145-01

TABLE 5-3. (Cont)

Circuit Reference No.	Description	Telonic Part No.
R421	Part of S401	
R422	RVC, 7.5MΩ, ±30%, 0.2W	29-0015-11
R423	RVC, 250KΩ, ±30%, 0.2W	29-0015-06
R424	RVC, 50KΩ, ±30%, 0.2W	29-0015-02
R425	RFC, 33KΩ, ±10%, 1/2W	26-0036-01
R426	RFC, 270KΩ, ±10%, 1/2W	26-0062-01
R427	RFCF, 100KΩ, ±1%, 1/2W	27-2569-01
R428	RFCF, 221KΩ, ±1%, 1/2W	27-2570-01
R429	RFC, 820KΩ, ±10%, 1/2W	26-0095-01
R430	Same as R403	
R431	RFC, 1.8MΩ, ±10%, 1/2W	26-0033-01
R432	Same as R310	
R433	Same as R425	
R434	RFC, 27KΩ, ±10%, 1/2W	26-0025-01
R435	Same as R310	
R436	RFC, 22KΩ, ±10%, 1/2W	26-0024-01
R437	RFC, 3.3KΩ, ±10%, 1/2W	26-0007-01
R438	RFC, 12KΩ, ±10%, 1/2W	26-0119-01
R439	Part of S401	
R440	Same as R103	
R441	Same as R431	
R442	RVC, 10KΩ, ±30%, 0.3W	29-0015-10
R443	Same as R127	
R444	Same as R103	
R445	Same as R103	
R446	Not assigned	
R447	Not assigned	
R448	Same as R405	
R449	Not assigned	
R450	Not assigned	
R451	Part of S403	
R452	Same as R404	
R453	RFC, 470KΩ, ±5%, 1/2W	26-0125-01
R454	RFC, 680KΩ, ±5%, 1/2W	26-0148-01
R455	Same as R453	
R456	Same as R454	
R457	RFC, 1KΩ, ±10%, 1/2W	26-0018-01
R458	Same as R405	
R459	Same as R426	
R460	Same as R426	
R461	RFC, 390Kp, ±10%, 1/2W	26-0072-01
R462	Same as R434	
R463	Same as R401	
R464	RFCF, 2.32MΩ, ±1%, 1/2W	27-2572-01
R465	RFCF, 1.3MΩ, ±1%, 1/2W	
R466	Same as R312	
R467	RDVW/C, 6μ, 2W/1MΩ, 1/3W	29-0018-01

TABLE 5-3. (Cont)

Circuit Reference No.	Description	Telonic Part No.
R468	Same as R127	
R469	Same as R416	
R470	RFC, 3.3MΩ, ±10%, 1/2W	26-0049-01
R471	Part of R467	
R472	RFC, 2.7MΩ, ±10%, 1/2W	26-0041-01
R473	RFCF, 470Ω, ±5%, 2W	28-0062-01
R474	Same as R457	
R475	Same as R104	
R476	Same as R426	
R477	RFC, 110KΩ, ±5%, 1/2W	26-0117-01
R478	RFC, 470KΩ, ±5%, 1/2W	26-0125-01
R479	RVC, 500KΩ, ±30%, 2/10W	29-0003-03
R501	Part of J501	
R502	Part of J502	
R503	Same as R442	
R504	Same as R442	
R505	Same as R442	
R506	Same as R442	
R507	Same as R442	
R508	Same as R442	
R509	Same as R442	
R510	Same as R442	
R511	Part of S509	
R512	RFC, 20KΩ, ±10%, 2W (2 req)	28-0037-01
R513	RFC, 47KΩ, ±10%, 1/2W	26-0027-01
R514	Same as R513	
R515	Same as R104	
R516	Same as R306	
R517	Same as R306	
R518	Same as R306	
R519	Same as R436	
R520	Same as R436	
R521	Same as R436	
R522	Same as R127	
R523	RFC, 6.8KΩ, ±10%, 1/2W	26-0109-01
R524	RFC, 3.9KΩ, ±10%, 1/2W	26-0040-01
R525	Same as R437	
R526	Same as R513	
R527	Same as R104	
R528	Same as R306	
R529	Same as R513	
R530	Same as R306	
R531	RFC, 470Ω, ±10%, 1/2W	26-0042-01
R532	Part of S510	
R533	Part of S510	
R534	Same as R513	

TABLE 5-3. (Cont)

Circuit Reference No.	Description	Telonic Part No.
S101	SWT, SPST	37-0032-01
S102	SWT, DPDT	37-0002-01
S301	ASW	37-0035-01
S401	ASW	37-0012-01
S402	ASW	37-0013-01
S403	ASW	37-0020-01
S501-S508	SWT, SPST	37-0005-01
S509	ASW	29-0023-01
S510	ASW	37-0021-01
V101	TE,0A2	42-0019-01
V102	TE, 5651	42-0015-01
V103	TE, 6J11	42-0031-01
V104	TE, EL34	42-0029-01
V105	Same as V104	
V301	TE, 6C10	42-0021-01
V302	TE, 6AU6	42-0068-01
V303	Same as V302	
V304	TE, EL84/6BQ5	42-0014-01
V401	TE, 6D10	42-0025-01
V402	Same as V401	
V403	Same as V302	
V404	TE, 6CM8	42-0022-01
V405	Same as V404	
V406	Same as V304	
V501	Same as V301	
V502	Same as V301	
V503	Same as V301	
V504	Same as V301	
Z201	Attenuator, 0-10 dB	97-6115-01
Z202	Attenuator, 0-50 dB	97-6035-02
Z501-Z508	Socket, wafer	44-0114-01
	Filter Housing	15-0088-01
	Indicator light mounting assembly	36-0015-01
	Fan	36-0037-01
	Fan Blade	09-4343-01
	Tube Socket, 7-pin (5 required)	44-0109-01

TABLE 5-3. (Cont)

Circuit Reference No.	Description	Telonic Part No.
	Tube Socket, 9-pin (4 required)	44-0110-01
	Tube Socket, octal (2 required)	44-0111-01
	Fuse Holder	36-0035-01
	Tube Socket, 12-pin (8 required)	44-0120-01

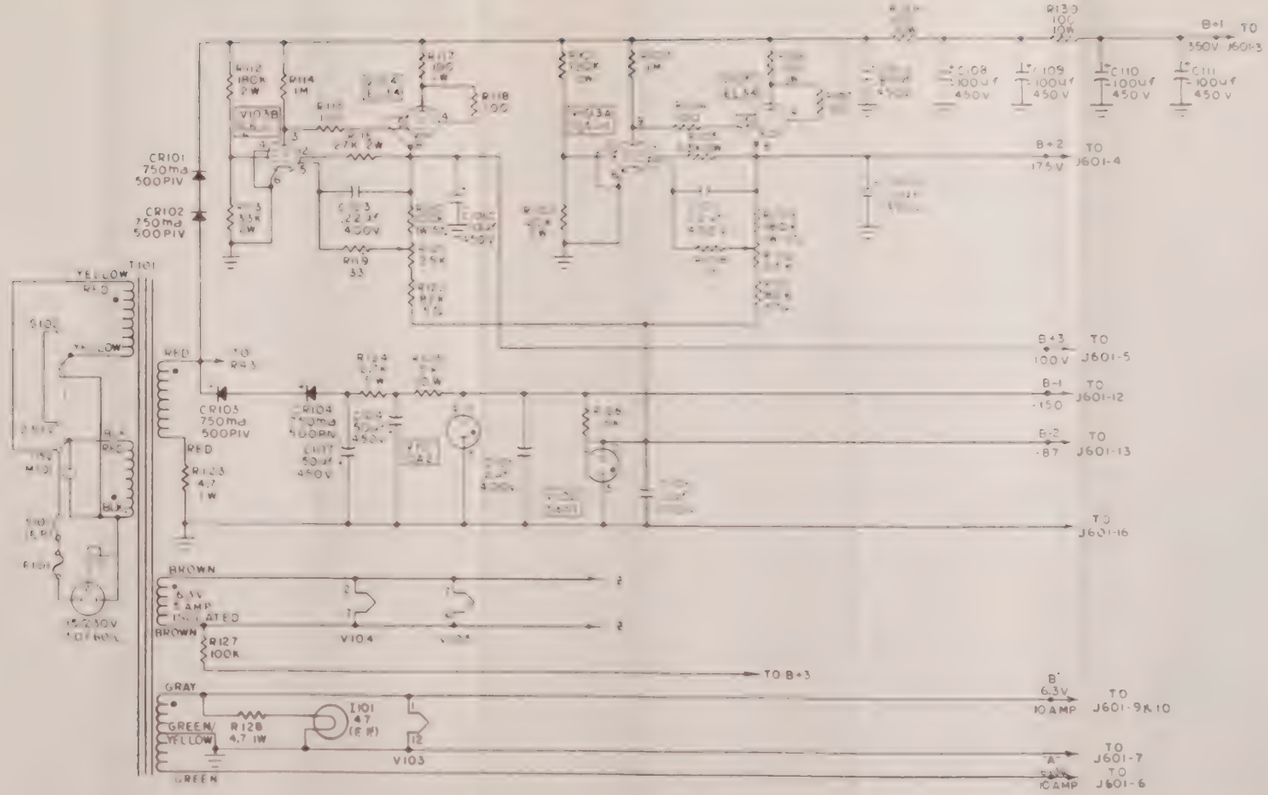


Figure 5-1. Power Supply

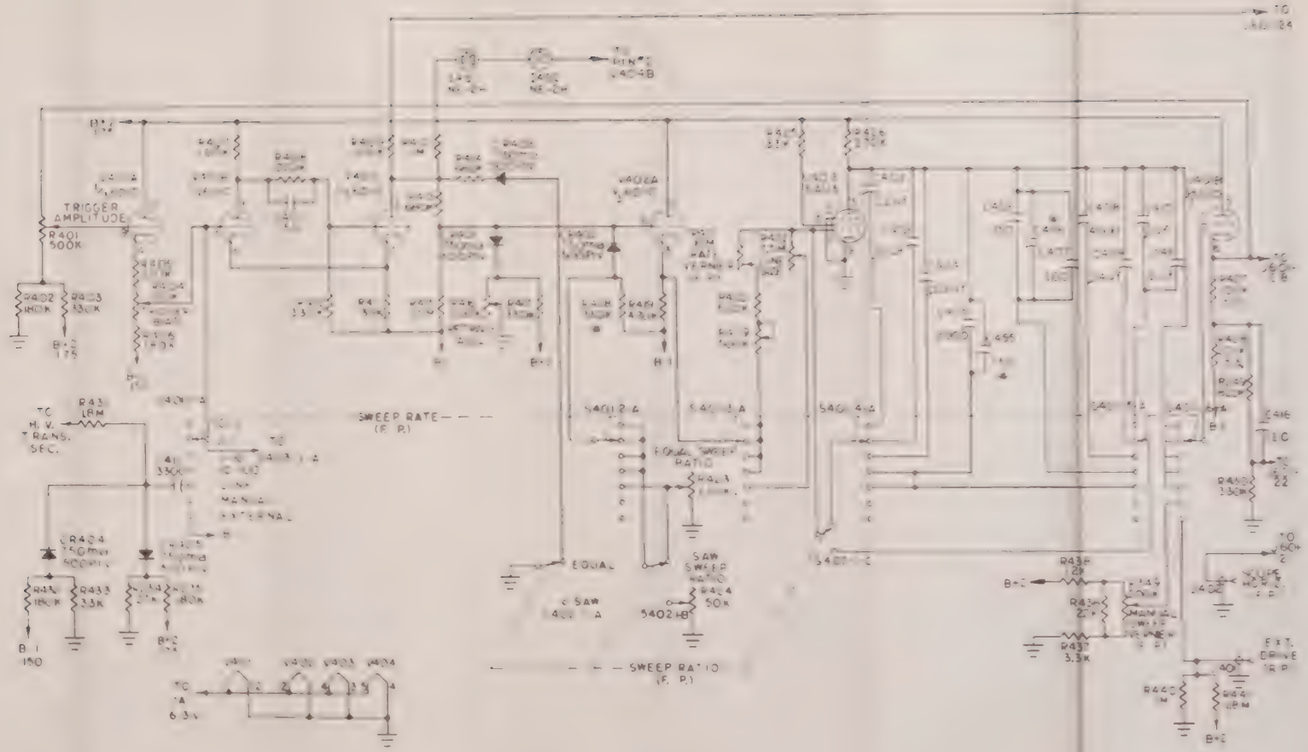


Figure 5-2. Vari-Rate

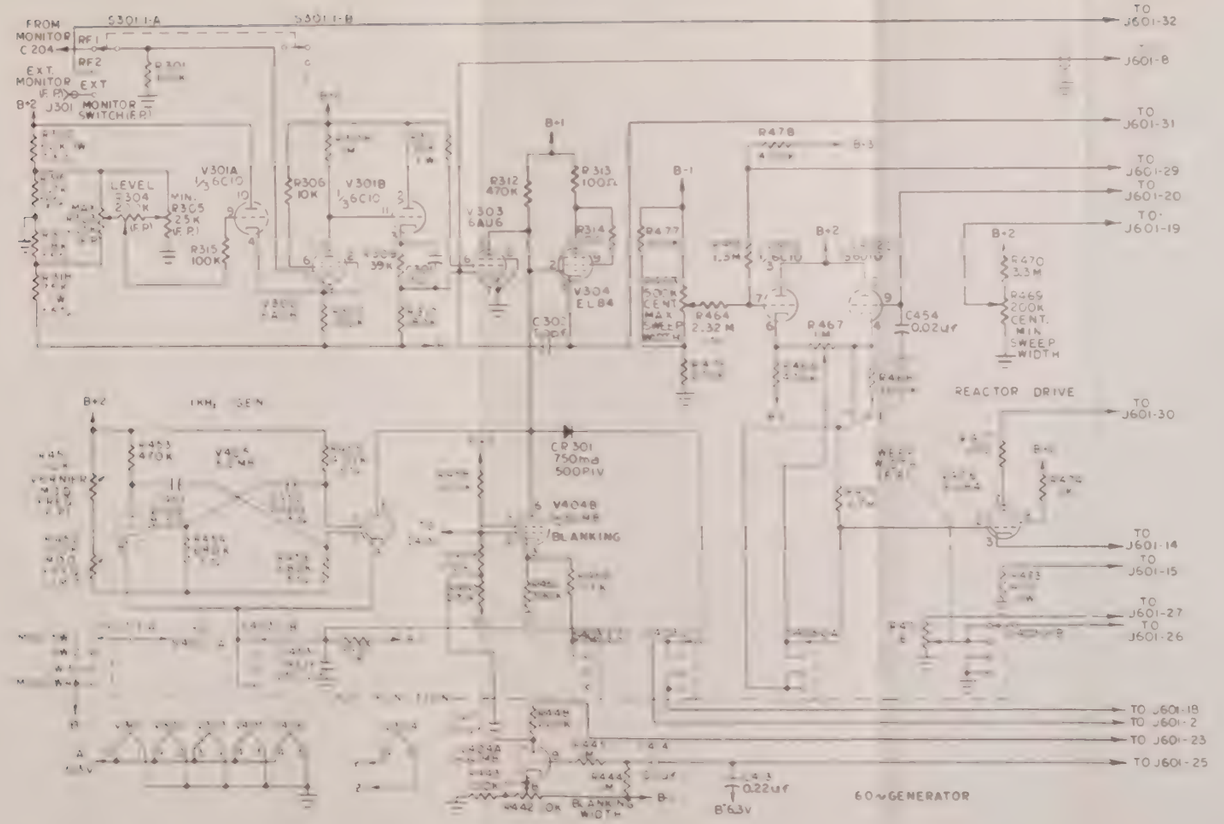


Figure 5-3. Leveler, Modulation, Blanking Reactor Drive and 60 Hz Generator

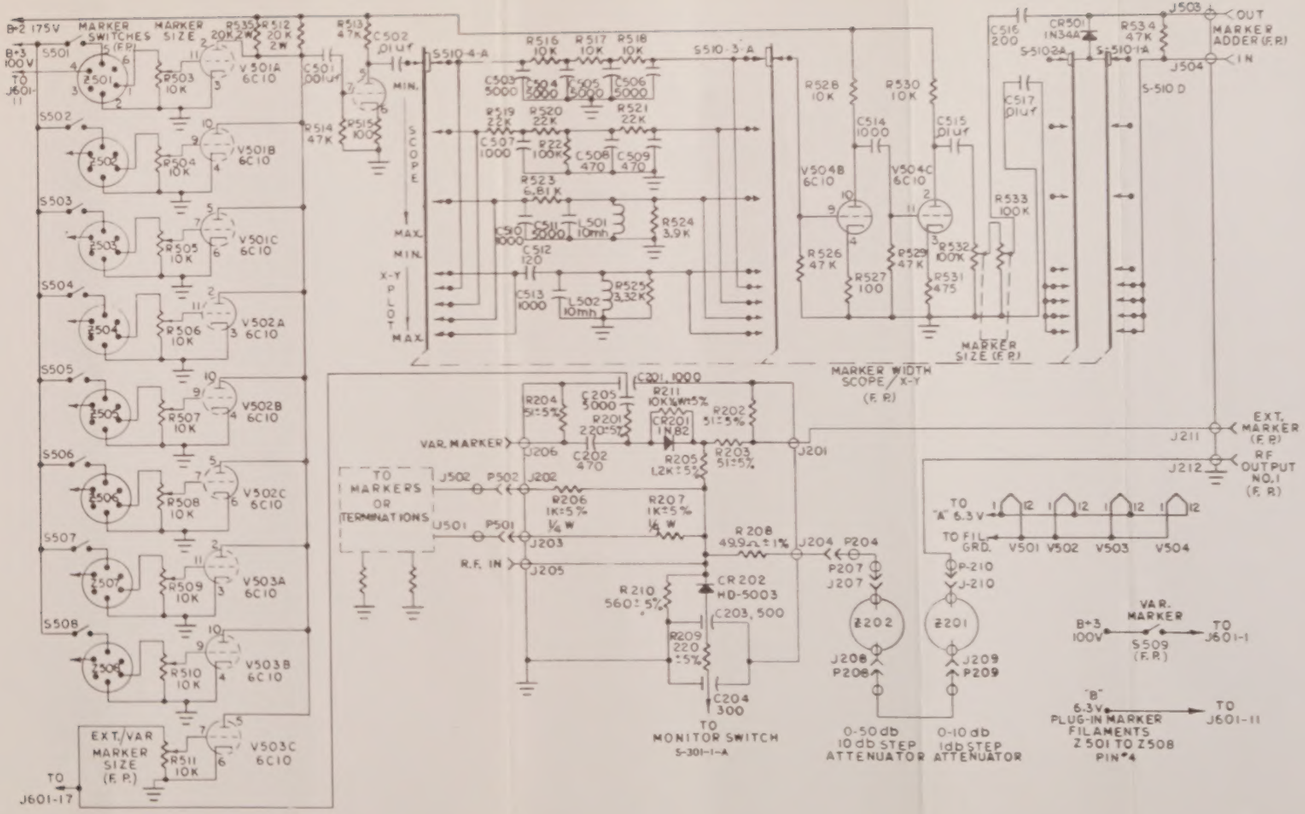


Figure 5-4. RF Circuits and Marker Mixer

ADDENDUM SHEET

Model SM-2000 Sweep/Signal Generator

The following changes shall be considered a part of this manual:

1. TABLE 5-3. Electrical Parts List.

   a. Change the Telonic Part No. of the following components to:

1.	C201	21-0013-01
2.	C202	22-0004-01
3.	C203	21-0015-01
4.	C204	21-0015-02
5.	C205	22-0011-01

   b. Change the description of capacitors C405 and C455 to:

1.	C405	CFM, 2000pF, ±5%, 500 VDCW
2.	C455	CFM, 150pF, ±5%, 500 VDCW (SC)

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